Profiling Application of Advanced Manufacturing Technology (AMT) in Indonesian SMEs

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Abstract: The role of SMEs in Indonesia is tremendous contribution to economic growth in Indonesia. Therefore, the Indonesian government has provided a great attention to the development of SMEs. The Indonesian government has been trying to encourage entrepreneurship development by supporting the development of small and medium enterprises in improving performance and increasing capacity. 99% of businesses are SMEs in Indonesia but only 56.7 % contribute to GDP is not as big as medium and large corporate contribution to GDP, mainly due to the limitations of SMEs still uses traditional technologies in the production process. Implementation of Advanced Manufacturing Technology on SMEs it is important to promote the development of SMEs in terms of productivity and effieceincy. In this study, researchers are exploring how far the use of AMT in improving the performance of SMEs in Indonesia. SMEs in the business sectors Food, Herbs and Craft will be taken as a case study in this research.

Keywords: AMT, SME, performance

Introduction

One of the effects of globalization on developing countries and developed countries is the accessibility to global markets resulting in increased economic growth (Raymond and Croteau, [12]). However, access to global markets the company is required to be able to meet customer needs in terms of quality and reliability of products, low prices and fast delivery (Monge *et al*, [9]). With the rapid growth of advanced technology, implementing the Advanced Manufacturing Technology (AMT) will be a competitive advantage for the company to compete in the global market as well as to penetrate the market as evidenced by Saleh and Ndubisi [12] that many Multi National Companies (MNCs) have success make more efficient in the process production by adopting AMT. Judging from the success of the Multi-National Corporations (MNCs) in adopting AMT, when applied to small industries especially have limited ability in applying certain technologies in operational processes, the question remains is: small firms will be able to compete in the global market place? However, interesting to note is that during the world crisis in mid-1998 when the performance of the industry declined sharply, Small and Medium Enterprises (SMEs) are able to survive and play an important role in creating economic survival and also make a significant contribution to economic growth both in developed and developing countries.

Literature Review

Advanced Manufacturing Technology (AMT)

Several conceptual schemes have been offered to grapple with the nature of AMT leading to valuable contributions to understanding AMTs. Raymond[11], for example, defines AMT as an automated production system of people, machine, and tools for planning and controlling of the production processes, including the procurement of raw materials, parts, component, shipment, and services of finished products. AMT involves new manufacturing techniques and machines combined with information technology, microelectronics, and new organization practice in the manufacturing process (Deruntz *et al*, [6]). AMT is a term used to describe a variety of technologies that use computers to control or monitor manufacturing processes (Jonsson, P., [8]). Supporting previous mentioned researchers, Monge *et al*, [9] defines AMT as a family of technologies used in all facets of manufacture including design, control, fabrication and assembly. More specifically, AMT can be described as a group of computer-based technologies, including: Computer aided design (CAD), Computer aided manufacturing (CAM), Materials requirements planning (MRP), Manufacturing resources planning (MRPII), Enterprise resources planning (ERP), Electronic data interchange (EDI), Optimized production technology (OPT), Quality control soft

ware (QCS), Statistical Process Control (SPC), Expert systems, Manufacturing automation protocol (MAP), Database management systems, Mainframe, Minis, LAN/WAN, Online process instrumentation, Shop floor data capture, Graphics hardware, Automatic assembly, Flexible assembly systems, Manufacturing cells, Automated warehousing/order picking, Automatic testing equipment, Equipment controlled by programmable automation, Robot-based operations, Numerical control machines (NC), Automated handling of materials, Flexible manufacturing systems (FMS) Implementations, Computer-based inventory management, Computer-based barcoding, Computer-based maintenance management, Computer-based production scheduling, ISO, Total Quality Management (TQM), Just in Time (JIT) (Narain *et al.* [9]; Raymond [11]; and Salaheldin [13]). These AMTs are classified into Direct AMT, Indirect AMT, and Administrative AMT. Hardware base technologies are termed as Direct AMT. Software-based technologies used for product design and scheduling are termed as Indirect AMT, however, Administrative AMTs are used for integration and simplification of business processes (Beaumont *et al.* [1]):

1. Direct. The technology is used on the factory floor to cut, join, reshape, transport, store or otherwise modify materials. The examples include numerically controlled machinery and production line robots (CNC,DNC, Robotics, FMS, AMHS, AGV, etc)
2. Indirect. The technology is used to design products and to schedule production. The examples include computer-aided design and drafting and scheduling system such as manufacturing resources planning (MRP II) and production monitoring systems. (CAD, MRP, SPC, BC, MRP II, JIT, etc)
3. Administrative. The technology is used to give administrative support to the factory and to integrate its operations with the rest of the organization. The examples include job-costing system, ordering and inventory systems, accounting and cost control systems and communication systems supporting electronic data interchange, and other forms of electronic business. (ABC, OA, etc).

Monge *et al.* [9] classify AMT as Direct manufacturing technologies (DMT), Administrative-information exchange – strategic technologies (AIET), Integrative manufacturing technologies (IMT), Administrative-planning technologies (APT). Sun [21], divides AMT into four categories based on implementation field: Planning and Controlling, Information resource management, Product design and development, Factory automation. Sun *et al.* [19] develop the classification of AMT to be completed as below:

1. Planning and Controlling: ERP
2. Information resource management: Technology databases/product data management (PDM),
3. Product design and development, LAN-WAN/ Intranet/shared database /internet, CAD, CAE.
4. Factory automation: Integrated design processing systems (CAD, CAE, CAM, CAPP), Numerical control machines, CNC, DNC, Computer aided inspection, FMS, FMC, automated tool change parts loading/ unloading robots, automated storage-retrieval system (AR/RS) and Automated guided vehicles (AGVs).

According to Small [18], and Vidyarthi and Laskhari [22], taxonomies of AMT are: Design and Engineering Technologies (D'PET), Fabricating / machining and Assembly (FMA), Automated Material Handling Technologies (AM HT), Automated Inspection and Testing Systems (AITS), Information Technologies (IT). Jonsson, [8], classifies AMT to five: design technology (AMTDES), Manufacturing Technology (AMT MFG), Administrative Technology (AMT ADM), Computer-based transaction of data between subunits (HINT1) and computer-based transaction of data between processes (HINT2). Small [17] classified AMT into 4 groups based on Factor analysis as Design Technology, Manufacturing Technology, Administrative Technology and Resource Planning Technology. Though different in term of classifying the group of AMT, given that AMT is based primarily on computer information-based technology, basically researchers classify AMT into hard technology and soft technology This broader view of AMTs facilitates the study of AMT implementation in SME because it permits the many dimensions of AMTs to be matched against several possible implementation strategies while studying the notion of fit and its implications for firm performance. Therefore, this conceptual classification of AMT forms the basis for the operationalization of AMT in this study.

Small Medium Enterprise (SME)

Currently, SME are very difficult to define because of many variations of definition based on each country and type of industry. There is no common definition of SME among nations as each country applies its own definition (Hashim, [7]). Some definitions of SME are determined by a number of factors and criteria such as location, size, age, structure, organization, number of employees, sales volume or value of assets, ownership through innovation and technology (Rahman, [11]). The most common practice is to rank firms by number of employees. But other variables like net assets, sales and investment levels are also sometimes used. There is also variation in defining the upper and lower size limits of an SME. Finally, the coverage varies depending on whether

the informal sector and micro firms are included or not. In Indonesia, definition of SMEs varies amongst different Indonesian government agencies: for example, according to the Ministry of Industry, a Small Enterprise is a business establishment with assets (excluding land and building) of less than 200 million rupiah; Medium Enterprises are from 200 million up to 5 billion rupiah; and firms of more than 5 billion rupiah are considered as Large Enterprises. A different definition is given by the Central Bureau of Statistics (Biro Pusat Statistik [BPS]), which classifies enterprises systematically according to the number of fulltime employees. From 0 to 4 workers a firm is classified as a Cottage or Household Enterprise (CHE), those with 5 to 19 workers as Small Enterprises (SEs), and those with more than 19 as Medium Large Enterprises (MLEs). According to the definition of the Ministry for Cooperative, Small and Medium Enterprises, SMEs involve people activity on a small to medium scale, with criteria as follows: 1) they have maximum net assets of up to 10 billion rupiah, excluding land and buildings; 2) they are owned by Indonesians; 3) they comprise independent companies not owned by a large company and directly or indirectly affiliated with a large enterprise; and 4) they are individual companies, with or without legal entity status.

Methods

Data

Two hundred and fifty three samples were collected from a few exhibitions held in Indonesia. The sample is taken from food and beverage industry, herbal industry and craft industry. The data collection method employed was distributed of questionnaire to the participants of the exhibition. Questionnaires were distributed to all exhibitors, but only a limited number of exhibitors agreed to participate in the study. The methodology used for data analysis is descriptive, chis-square test and Wilcoxon Sign Method to test the impact of AMT on company performance. These testing hypothesis use 5% of the significance level.

Results and Discussion

Organization Profile

Sample obtained from this survey is 253 respondents and consists of some of the following industries: Food & Beverage industry of 45.1%, 15,4% of Herbal Industry and Craft Industry of 37.2 %.

The length of operating companies is very diverse ranging from 6 months to tens of years. SME can be divided into 3 groups based on Indonesian SME definition, namely micro, small and medium.

Table 1. AMT application.

AMT	*Freq.*	*Valid %*	*Cumulative %*
No	155	61.3	61.3
Yes	98	38.7	100.0
Total	253	100.0	

Table 2. Percentage of the reason why the company does not implement AMT

Reason	%
Financial constrain.	96.1
Difficulty in data analysis, measurement and documentation	94.2
High investment	91.7
Not clear benefit for using AMT	89.0
Computer obsolete	87.7
Lack of appropriate technical knowledge	85.8
AMT is not appropriate to the company	80.6
Lack of employee involvement	80.0
Lack of top management involvement	77.4
Small size of market	66.4

Limitation of sales turnover for the micro category is less than 100 Million Rupiah, small is between 100 Million to 1 Billion Rupiah and medium industry is between 1 Billion to 10 Billions Rupiah. From the survey, it is found that the percentage of micro industry is 54.5 %, small industry is 20.2% and 20.6% of respondent as a medium industries. Average of employee in the company is 43 people and ratio skilled employee to total employees is 15.3%.

Type of ownership is a family business for 62.1%, 24.1% is Share Holding and 13.8% is joint venture. Type of ownership as a family business is still dominant in Indonesian SME.

AMT Application

Table 1 explains that 98 companies or 38.1 % of the total respondents are implemented AMT. And the rest is not using the AMT. The reason why they do not use the AMT is very diverse. The high reasons are financial constrain and high investment for AMT application. The other reasons are not clear in Knowledge of AMT such as not clear of AMT's benefit, lack of appropriate technical knowledge and difficulties data analysis, measurement and documentation.

All reasons of why the company does not apply AMT can be seen in table 2. Interesting reasons when the company does not apply AMT because does not require AMT are around 80.6%. Therefore percentage of the company implement AMT becomes 76.6 %.

The AMT application in production process is started from the input, transformation, output and environment and also AMT application can be classified as a soft technology and hard technology.

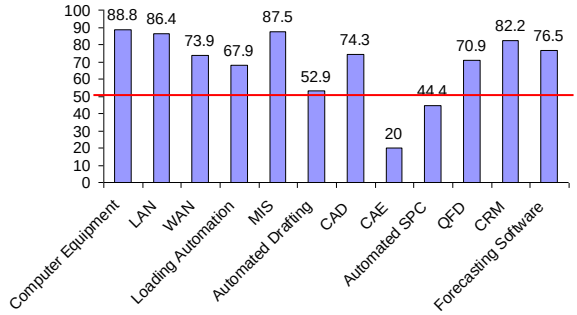

Figure 1. AMT application in input process

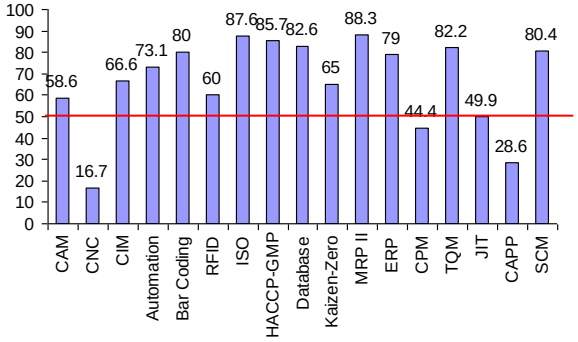

Figure 2. AMT application in transformation process

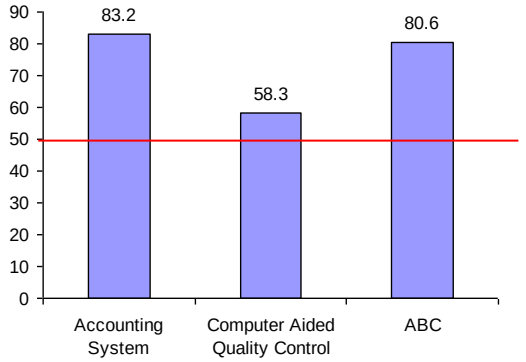

Figure 3. AMT application in output process

MIS, Automated Drafting Technologies, CAD, CAE, Automated Statistical Process Control, Quality Function Deployment, CRM, and Forecasting can be classified as soft technology in the input process. Hard technology can be classified as follows Computer Equipment, LAN, WAN, Automation and loading and unloading.

In Figure 1, the use of hard technology in the input process are four hard technologies, but only 3 of hard technology is over 50 % highly used of AMT such as Computer equipment, LAN, WAN. Ratio of usage of AMT in the input process is 75%. The use of soft technology at the input process is 8 and only 4 which have values above 50% high usage such as MIS, CAD, CRM and Forecasting Software. The percentage of soft technology used in the process input is 50%. From the input process, the use of hard technology is higher than the use of soft technology.

Classification of soft technology in the Transformation process can be described as ISO, HACCP-GMP, Database Management System, Kaizen, Zero, Defect Program, MRPII, ERP, CPM TQM, JIT, CAPP, and SCM. And as a hard technology are CAM, CNC, CIM, Automation of Testing equipment, Bar Coding, RFID. As the output is classified as a soft technology are Accounting System and Activity Based Costing (ABC). Classification of hard technology in Transformation process is Computer Aided Quality Control perfumed on final product. Figure 2 indicate the use of AMT in Transformation Process. In the process of transformation can be known that the highest use of hard technology is Bar Coding Technique (80%). Use of Soft Technology in the transformation process is ISO, HACCP, GMP, Database Management, MRP II, TQM, and SCM. There are 6 soft technology used in the process of transformation, this can be said that there are 72.7% the use of soft technology in the transformation process. The use of hard technology in the transformation process is 83.3 %. From both technologies, the use of hard technology in transformation process is greater than soft technology. Hard technology is the core of the transformation process. So hard technology should always be in the process of transformation, but to optimize production and to improve productivity and needed a soft technology. For example is the use of soft technology, such as TQM, MRP and SCM were used for the optimization of productivity. Besides the basic requirements for food & beverage industry and Herbal industry are GMP-HACCP, ISO, and data base management.

In the Output Process, Technology can be classified into hard technology such Computer Aided Quality Control as control of quality product and soft technology is Accounting System and ABC as control of financial system.

Figure 3 shows that two soft technology used it as an Accounting system and ABC. The use of soft technology in output process is 100%. Another case with hard technology, there is only one as hard technology and used it so that the use of hard technology in output process is 100%. Comparing from two technologies, the use of hard technology is similar than the use of soft technology.

In the Environment, Technology can be classified into hard technology such as Heating, Ventilation, and Air Conditioning System (HVAC) and as soft technology are Occupational Safety and Health Administration System (OSHAS). Similarly, in Figure 4 as a known that HVAC as a hard technology widely used by respondent was 71.4%. So the other word said

that use of soft technology in environment is 100%. Likewise the use of soft technology as OSHAS has 74.4 % of the respondent who said that the use of this OSHAS high and very high. Table 3 indicates that overall of use of soft technology is 77.3 % and 91.6 % of hard technology.

Relationship between the AMT Application and Sales Turnover, Profitability and Organizational performance.

There is a presumption that the large company easier to implement AMT, this is in the associate with the availability of resources both financial and human resources knowledge.

Table 8 shows that Comparison of the number of industries that use AMT and industries that not use AMT, there are significance increase. In the category < 100 Millions (Micro Enterprises) seen that the number of industries that do not use as much as 87.7% and is higher that small enterprises and medium enterpriseCross Tabulation data in Table 4 can be tested whether there is a relationship between the use of AMT and Org. Sales turnover.

The result from the Table 5, prove that value of significance in Pearson chi-square less than level of significance. So there is significance relationship between the use of AMT and Organizational sales turnover. Table 6 shows that the percentage of company that uses the AMT has increased the profitability higher than the company does not use the AMT.

A significance of increasing in the percentage of number of industries show that the use of AMT will impact on profitability. The chi square test result in Table 7 shows that value of significance as 0.00 is less than 5 % of significance level. There is relationship between the companies which use of AMT with Profitability rate.

Table 8 the value of organizational performance which use of the AMT and does not use of the AMT is different. Companies which use of AMT are better performance than companies which do not use of AMT. This indicates that Using AMT has a very high benefit to reach a company's aim which has been stated in the mission and vision. Its can provide benefits to improving the quality of product and services. It can increase financial performance in the growth sales turnover and profitability

To test the differences impact of AMT between companies which use of AMT and not use AMT, Wilcoxon Signed Rank test in table 9 has been proven that there is significant difference impact of AMT with 5% of significance level.

Table 3. Percentage of AMT application in production process

Process	% of AMT Application
Input	83.3
- Soft technology	75.0
- Hard Technology	100.0
Transformation	76.5
- Soft Technology	72.7
- Hard Technology	83.3
Output	100.0
- Soft Technology	100.0
- Hard Technology	100.0
Environment	100.0
- Soft Technology	100.0
- Hard Technology	100.0
Overall	
- Soft Technology	77.3
- Hard Technology	91.6

Table 4. Relationship between the use of AMT and org. sales turnover

			Using AMT		Total
			no	yes	
Org's Sales Turnover	< 100 Million Rp	Count	136	2	138
		% within Using AMT	87.7%	2.0%	54.5%
	100 Million - 1 Billion Rp	Count	18	33	51
		% within Using AMT	11.6%	33.7%	20.2%
	1 Billion - 10 Billion Rp	Count	0	52	52
		% within using AMT	.0%	53.1%	20.6%
	> 10 Billion Rp	Count	1	11	12
		% within using AMT	.6%	11.2%	4.7%
Total		Count	155	98	253
		% within using AMT	100%	100%	100%

Table 5. Chi-Square tests for org. sales turnover with use of AMT

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.918E2	3	.000
Likelihood Ratio	243.765	3	.000
Linear-by-Linear Association	173.669	1	.000
N of Valid Cases	253		

Table 6. Relationship between the use of AMT and profitability

		Using AMT		Total
		no	yes	
Org's Profitability	Decreased	5	0	5
		3.2%	.0%	2.0%
	Stagnant	76	15	91
		49.0%	15.3%	36.0%
	Increases slightly	73	33	106
		47.1%	33.7%	41.9%
	Very much increased	1	50	51
		.6%	51.0%	20.2%
Total		155	98	253
		100%	100%	100%

Table 7. Chi-Square tests for profitability with use of AMT

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.003E2[a]	3	.000
Likelihood Ratio	115.000	3	.000
Linear-by-Linear Association	81.557	1	.000
N of Valid Cases	269		

Table 8. Relationship between the use of AMT with the organizational performance.

Org. Performance	Not using AMT	Using AMT
Clear Mission	69.7	91.9
Develop good product and services	57.5	93.9
Ability to retain employees	31.6	76.6
Make realistic commitment to customer	51.6	93.9
Teamwork	32.3	62.2
Treat employees with respect & dignity	39.4	90.8
Growth sales increase effectively	28.7	78.5
Profitability increase effectively	16.8	80.6
Proud to tell friends & people with the good one	37.7	71.5
Good communication	34.4	84.7
Financial Performance highly satisfactory compare to the other company	30.3	84.7

Table 9. Wilcoxon signed rank test.

	Using – Not using
Z	-2.934[a]
Asymp. Sig. (2-tailed)	.003

Conclusion

This research concludes that the AMT Application in Indonesia is 76.6% and the rest does not use AMT. The highest reason the company does not use the AMT is financial constraint amounting to 96.1%. If company look at the clear of AMT benefit such as growth of annual sales turnover, increased profitability and high organizational performance, the company will be provided a high chance to open new market and will increase to national economic growth.

AMT has been classified in two groups of soft technology and hard technology. The AMT application in hard technology widely used in the input process, transformation, output process, and Environment. Soft technology is being widely used in the transformation process. This means that for the optimization of production processes will be more emphasis on the use of soft technologies. To control product quality is more emphasis on hard technology. Both technologies including hard technology and soft technology are mutual support or complementary to one another. The basis of the production process begins with the use of hard technology, followed with the use of soft technology as an optimization in production system.

Analysis of the relationship between the use of AMT with sales turnover, profitability and Organizational performance obtained results that are significance relationship between AMT Application and annual sales turnover, profitability rate, Organizational performance. Companies with high sales turnover and high profitability are more applied AMT than companies with low sales turnover and low profitability. Thus small company with low profitability and low sales turnover is more difficult to implement AMT. Many micro or small enterprises tend not to use the AMT because of financial difficulties and also AMT does not appropriate to his company. Micro and Small Enterprises are still using manual production process due to low market demand and low quality requirements.

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